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Nr. 8. Johs. Schmidt: ON THE POST-LARVAL DEVELOPMENT OF SOME NORTH ATLANTIC GADOIDS (*RANICEPS RANINUS* [LINNÉ] AND *MOLVA ELONGATA* [RISSO]). WITH ONE PLATE AND ONE FIGURE IN THE TEXT

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
BIANCO LUNOS BOGTRYKKERI
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ON THE POST-LARVAL DEVELOPMENT OF SOME NORTH ATLANTIC GADOIDS

(*RANICEPS RANINUS* [LINNÉ] AND *MOLVA ELONGATA* [RISSO])

BY

JOHS. SCHMIDT

WITH ONE PLATE AND ONE FIGURE IN THE TEXT

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I. INTRODUCTION

In various earlier papers[1] I have described the post-larval development of most of the North Atlantic gadoids occurring at moderate depths. The material has been collected in the course of the four years (1903—1906) the Danish investigation-steamer "Thor" has been making cruises in the Atlantic, extending from the Polar Circle north of Iceland to the north coast of Spain.

An exception is formed by the genus *Onos (Motella)*, the numerous in part but badly known species of which require a careful revision, even as regards the adult fish. The material collected by me seems however scarcely sufficient to permit of a connected description of the developmental histories of the species belonging to this genus, at least as regards several of them; and it is hardly probable that this condition of things will soon be altered, as the investigation-steamer "Thor" will most probably not work in the Atlantic in future, but in Danish waters and the North Sea where but few *Onos*-species are common.

For this reason the present paper forms a sort of conclusion, at least for the time being, of my systematic studies on the post-larval stages of the gadoids. On the other hand I hope to publish within the near future a connected account of the biological side, namely, of the distribution and occurrence of the young, pelagic stages of the gadoids within the region investigated by us, a work for which the systematic descriptions of the single species was a necessary preliminary and basis.

In the following pages I shall describe the developmental history, firstly of *Raniceps raninus* and then of *Molva elongata*. These two species constitute the greatest contrast to one another, the form of the post-larval stages in the first being the plumpest that of the second the most slender of all the North Atlantic gadoids, as can be seen by a glance at the figures on Pl. I.

With regard to the terminology used in the descriptions, especially of the pigment, see my earlier papers cited on below.

The following abbreviations are used here:

D_1 = 1st Dorsal Fin
D^2 = 2nd do.
A = Anal Fin
C = Caudal do.
P = Pectoral do.
V = Ventral do.

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[1] (1) Johs. Schmidt: The pelagic, post-larval stages of the Atlantic species of *Gadus*. Part I, Meddelelser Komm. Havundersøgelser, Serie Fiskeri, Bind I, Nr. 4, 1905.

(2) Idem: Part II, ibid., Bind II, No. 2, 1906.

(3) Idem: On the larval and post-larval stages of the Torsk (*Brosmius brosme* [Ascan.]), ibid. Bind I, No. 8, 1905.

(4) Idem: On the pelagic, post-larval stages of the Lings, (*Molva molva* [Linné] and *Molva byrkelange* [Walb.]); ibid. Bind II, No. 3, 1906.

(5) Idem: On the post-larval development of the Hake (*Merluccius vulgaris* Flem.); ibid. Bind II, No. 7, 1907.

II. LESSER FORKBEARD (*RANICEPS RANINUS* [LINNÉ])

A few post-larval stages of this species are mentioned in the literature. Thus, a specimen of 13 mm. in length was taken by A. W. Malm[1] at Lunnevik in Bohuslän in July (23rd); and a second 9 mm. long was taken on October 29th in the Moray Firth between Coversea and Burghead and was described and figured by W. C. Mc Intosh.[2]

With regard to the eggs and larval stages of this Forkbeard, reference may be made to Fr. Heincke and E. Ehrenbaum's work: "Eier und Larven von Fischen der deutschen Bucht"[3], where some small pelagic eggs (diameter 0·755—0·912 mm. and with an oil-globule) taken at Heligoland during the summer are described and figured; these belong most probably to *Raniceps*. The larvæ hatched from these eggs are also figured and described; they are pigmented yellow and black; finally a somewhat older larva of ca. 4 mm. in length taken at Heligoland on July 20th 1896 is mentioned. This had already elongated ventral fins, which had black pigment on the tips.

1. Description of the developmental history

Pl. I, Fig. 9 **Length: 5 mm.** The preanal part of the body is unusually high in proportion to the short length of the animal. The head is high and arched, and the snout rounded. Seen from the side the fish reminds one not a little of the small fry of the *Liparis*-genus, but the trunk is still not so thick anteriorly as in that genus. During the later development the preanal part increases so enormously in thickness that the body becomes shortly clavate as in *Liparis*. The anus is placed relatively far back, not much in front of the centre of the body.

The end of the notochord is still practically quite straight and very heavy.

The body is surrounded by the embryonic fin in which embryonic rays can be seen. Traces of the hypural and epiural elements can be noticed in front of the end of the notochord at the region of the caudal fin, but rays are not yet formed, though a more opaque part below in the embryonic fin denotes where they will develop. Only embryonic rays are present in the dorsal and anal fins, but the incipient interspinous region extends from in front backwards like a streak close up to the contour of the body.

The pectorals are rayless, fan-like flaps. The ventrals which arise in front of the pectorals almost halfway along the preanal portion of the trunk, are very elongated, so that they reach some distance behind the anus. They contain 6 rays with very black pigment between these, so that with the naked eye alone they seem quite black.

The pigment is weak and not specially characteristic. On the supraorbital, postoccipital and pectoral regions dorsally there are some well-marked chromatophores, and some fine dashes behind the eyes and round the basis of the pectoral. The abdominal pigment is extremely faint; nor is the ventral preanal pigment strong; it consists of some few chromatophores in front of and behind the basis of the ventral fin. An inconsiderable amount of anterodorsal or anterodorso-lateral pigment is present, — the first beginnings of the pigment which gradually spreads itself from before backwards over the lateral aspects

[1] A. W. Malm: Göteborg och Bohusläns Fauna, p. 499, 1897.

[2] W. C. Mc. Intosh: Contributions to the life-histories and development of the food and other fishes. XVth Annual Rep. of the Fishery Board for Scotland, p. 209, Pl. VI, Fig. 7—8, 1897.

[3] Wissenschaftliche Meeresuntersuchungen, III, Helgoland, 2, 1900, p. 258—60, Pl. IX, Fig. 15—17.

during the postlarval development, just as is the case for example in the haddock *(Gadus æglefinus)*. The postanal pigment is exceedingly faint; a few fine dashes without order are present, especially dorsally, and there is also a single, slightly larger chromatophore almost halfway between the anus and the caudal fin. Thus, there is no sign here of the arrangement of the postanal pigment into 3 bars, as is found in so many other gadoids (e. g. *Gadus saïda, callarias, virens, pollachius, Molva, Brosmius* and *Merluccius*).

Length: 7½ mm. This specimen is much further on in development than the previous and is also much plumper and especially thicker anteriorly, so that its form resembles the *Liparis*-genus even more than the first. The anus lies very far back, but a little way in front of the middle of the body. The end of the notochord is somewhat bent upwards and reduced, and rays are present everywhere in the caudal fin though they are not yet distinctly formed posteriorly round the tip of the notochord. The caudal fin like the other unpaired fins is characteristically thick. From the interspinous rays in the caudal to the interspinous rays in the dorsal and anal there is only a short space, so far back have the last two fins now reached. The embryonic fin is a little lower opposite the interspaces between the caudal and dorsal and anal fins. In D^2 about 60 rays could be counted, but the number could not be exactly determined; this applies also to the anal fin where the number was likewise about 60. The rays in these fins are extremely closely placed, which in conjunction with the fact that they are enclosed in a specially thick membrane makes it more difficult to count them than is usually the case. The interspinous rays in the dorsal and anal fins are unusually long. D^1 is not definitely separated from D^2. Pl. I, Fig. 10

The ventrals reach to a little behind the anus. They contain 6 rays, bound together in a common skin. Between the rays there is very black pigment.

With regard to the pigment on the body, in addition to that on the supraorbital and postoccipital regions there are some scattered spots behind the eyes and laterally on the abdomen, but the ordinary oblique abdominal pigment that usually follows along the upper line of the gut is absent.

The ventral preanal pigment consists of some chromatophores in front of and behind the base of the ventral fins; posteriorly it does not extend to the anus.

Since the last stage, the postanal pigment has developed considerably posteriorly. Thus we now find, in addition to the (antero)dorsal or -dorsolateral which has become more marked, some large stellate chromatophores medially on the side in front. Posteriorly this pigment reaches almost halfway along the dorsal and anal fins.

Length: 9½ mm. The form of the body is still shortly clavate, the preanal part being so exceedingly heavy (both in height and thickness) in comparison with the postanal. Pl. I, Fig. 11

The anus lies a little further forward than in the previous stages.

The notochord is somewhat more reduced and more bent upwards than before The caudal fin in which rays are everywhere present is still not completely separated from the dorsal and anal fins, but the embryonic fin opposite the interspace between them is very low. The rudimentary 1st dorsal is faintly pronounced but not separated from the 2nd dorsal. In the latter (D^2) about 65 rays were counted and in the anal about 60. The interspinous rays in the dorsal and anal fins are unusually long and remind one very much of a row of closely placed, paling posts. The rays in D^2 and A are also very long, so that these fins are very high.

The ventrals, which contain 6 rays the innermost being shortest the second outermost longest, and which are deeply black pigmented between the rays, reach posteriorly somewhat behind the anus. With exception of the ventrals absolutely no pigment is present on the fins.

With regard to the preanal pigment, that on the supraorbital and postoccipital regions is well-marked, and there are also some scattered chromatophores laterally behind the eyes and round the pec-

torals as well as on the abdomen, where they are specially large. The ventral preanal pigment is well marked, especially in front of the base of the ventrals, where it shows signs of arranging itself into a V-form. Posteriorly it extends only a little behind the base of the ventrals.

The postanal pigment extends somewhat further backwards than in the last stage and has on the whole increased in strength. It consists of large stellate, still widely separated chromatophores, which are placed medially on the sides or almost medially. Posteriorly this pigment reaches to a little behind the centre of the postanal part of the body, so that a large part of the body is quite free of pigment.

Pl. I, Fig. 12 **Length: 12 1/4 mm.** The body is typically clavate, the preanal part being very high and almost as thick as high whilst the postanal part is slender (cf. the characteristic form of the dorsal contour in the specimen figured). The snout is much rounded and the eyes relatively small; a trace of a barbel is present. The position of the anus has gradually and slowly moved forwards. It is now so far in front of the middle of the body that the preanal length is about equal to the distance from the anus to a little behind the beginning of the caudal fin.

The end of the notochord is now much reduced and bent upwards and its free part is very short in proportion to the length of the caudal fin rays. These are everywhere thick and strong with exception of the very first above and below. The hind margin of the most posterior hypural bone is now vertical and supports 6 rays. In front the caudal meets D^2 and A, but is now quite separated from these as the remains of the embryonic fin between them have now disappeared. In the very small D^1 which is now rather distincly separated from D^2 we find 3 rays, in D^2 65—66 and in A 58 rays.

The ventrals reach posteriorly some distance behind the anus; they contain 6 rays, of which the two inner are the shortest and the second from the outside the longest. The ventrals are still pigmented black; all the other fins lack pigment.

The preanal pigment is somewhat denser than in the previous stage but otherwise has the same distribution.

The postanal pigment consists of numerous, dense, large stellate chromatophores, which cover the sides and give these a brown colour in preserved specimens. On the other hand, the interspinous regions and the fins are free of pigment. Posteriorly the pigment does not reach by some distance to the beginning of the dorsal fin, so that a large part of the tail is still free of pigment.

Pl. I, Fig. 13, 13 a, 13 b **Length: 17 1/4 mm.** The form of the body is somewhat more slender than before and the dorsal contour thus more even, but it is still plump, the preanal part being extremely thick as can be seen in Fig. 13 a and b, where the animal is viewed both from above and below. The position of the anus is a little further forward than in the last stage, so that the preanal length from snout to anus is about equal to the postanal minus the length of the caudal fin.

The snout is much rounded and the upper jaw projects forward beyond the under. A small barbel is present. The caudal fin is oval and fairly narrow. The basal parts of the caudal and the other unpaired fins are characteristically thickened and opaque, a condition I have also noticed in the older postlarval stages of the torsk (*Brosmius*).

In the anal fin there were ca. 60 rays and in the 2nd dorsal ca. 68; in the small rudimentary 1st dorsal which is separated from the 2nd there were 3 rays. A and D^2 are both very broad. The pectorals are extremely large, fan-like with all the rays present; they reach posteriorly a good deal behind the anus. The ventrals, which contain 6 rays (the innermost of which is the shortest, the second outermost the largest) reach a good distance behind the anus. They are still black pigmented whereas the other fins have no pigment at all.

The greater part of the body is now strewn with numerous, densely placed, chromatophores. There is a difference from the previous stage, in that the interspinous regions of the dorsal and anal fins are now also covered with pigment and that the pigment extends still further backward, so that it almost reaches the beginning of the caudal fin. The end of the tail is thus free of pigment but this does not end abruptly posteriorly.

It seems superfluous to describe in detail the still older developmental stages, as these in form etc. so much resemble the adult fish that their determination should always be easy. A specimen of ca. 20 mm. in length taken on October 2nd 1891 by the Danish Biological Station in Fænö Sound (Little Belt) has for example already the form of the old fish in the main. The front part of the body is thus very broad and flat and the rudimentary D[1] has its final form. So far as one could see, the sides were quite covered with pigment right to the end of the tail.

2. Verification of the determinations

By reason of the very remarkable and extraordinary form of the postlarval stages described, their identification as belonging to the developmental history of *Raniceps raninus* was not bound with much difficulty, especially as we now know the young stages of almost all the North Atlantic gadoids occurring in shallow waters. Further definitive certainty of the correctness of the determinations is also found in the number of vertebræ in the postlarval stages described, which had the quite unusually low number of trunk-vertebræ[1], namely only 11, which is not known in other representatives of this family, at least not in those that occur within the region investigated by us. There can therefore be not the slightest doubt that the postlarval stages described and figured really belong to *Raniceps raninus*.

3. Distinction between the post-larval stages of the Lesser Forkbeard *(Raniceps raninus)* and related forms

In an earlier paper[2] I have given a summary of the characters by means of which the postlarval stages of the various North Atlantic genera can be grouped together, and reference may be made there for the groupings. Here I need only mention that the characteristically plump form of the body in the postlarval stages in the *Raniceps*, even at the small size of 5 mm., makes this species readily distinguishable. At a length of about 10 mm. especially the *Raniceps*-young are remarkable for the distinct clavate form of the body, which comes from the fact that the preanal portion is so extraordinarily high and thick, reminding one more of what we find in the young of *Liparis* than what we are accustomed to in the gadoids. This is seen distinctly in fig. 12 of Pl. I, where we notice especially the characteristic dorsal contour. In the somewhat older postlarval stages (fig. 13, Pl. I) the dorsal contour becomes more even or straight by the postanal part of the body increasing in height, but even in these the head and on the whole the preanal portion are very thick (cf. Pl. I, fig. 13 a and b), just as is the case also in the adult stages of the Lesser Forkbeard.

[1] Lilljeborg (Sveriges och Norges Fiskar, vol. II, Upsala, 1891) gives 11 trunk vertebræ and 33—34 caudal vertebræ for *Raniceps raninus*.
Krøyer (Danmarks Fiske, vol. 2, p. 245) gives 11 + 34 vertebræ.

[2] Johs. Schmidt: On the postlarval development of the Hake (*Merluccius vulgaris* Flem.). Meddel. fra Kommissionen for Havundersøgelser, Serie: Fiskeri, Bind II, No. 7, 1907.

Along with the genera *Onos (Motella)* and *Merluccius*, *Raniceps* belongs to the gadoids in which the ventrals are not so extremely elongated in the postlarval stages as is the case in *Molva* and *Brosmius*.

With regard to the pigment, the characteristic grouping of the primary postanal pigment into 3 bars, the most posterior of which is at the end of the tail the most anterior somewhat behind the anus and from which the further development of the postanal pigment proceeds, is lacking in *Raniceps*. In this the pigment which is situated over the pectoral region gradually spreads backwards to cover the sides behind the anus, until in the somewhat older stages (about 20 mm.) the sides are quite covered by densely placed chromatophores to the end of the tail.

III. *MOLVA ELONGATA* (RISSO)

The early developmental history of this species is so far as I know quite unknown[1]. The form occurs in the Mediterranean where it is common; according to our investigations it also occurs in the Atlantic S.W. of the British Isles. Holt and Byrne[2] mention the discovery of a ling taken in the trawl by the Irish steamer "Helga" to the W. and S.W. of Ireland and say regarding it: "*Molva elongata* Risso. A ling taken at 120 fathoms appears to so far combine the characters of the supposed Northern and Southern species of deep-sea ling (*M. abyssorum*, Nilsson and *M. elongata*, Risso) as to render it reasonably certain that a single species is enough for the reception of both".

Holt and Byrne thus seem to hold the view, which was also put forward by Nilsson (Skandinaviens Fauna, vol. 4, 1855), that the *Molva elongata* described by Risso[3] from the Mediterranean is possibly identical with the northern *Molva byrkelange* (= *M. abyssorum* Nilss.). This question was discussed by Lilljeborg (Sveriges och Norges Fiskar, vol. II, p. 140—42, 1891), who compared both forms carefully and came to the result that they were distinct species. Lilljeborg thus states that the scales in *M. byrkelange* are "oval or elliptical with very distinctly pearl-like, concentric streaks placed close together, whereas in *M. elongata* they are somewhat broader, rounded, oval or ovo-elliptical with numerous single (not pearl-like) streaks". Further, he gives exact measurements of two specimens of the two species of about the same size which show that they are though not very far removed yet distinct from one another. Thus the height of the trunk is considerably greater in *M. byrkelange* than in *M. elongata*, the total length being only 10 times the height in the former but 14 times in the latter, etc. etc.

I must agree with Lilljeborg's view that *M. byrkelange* and *elongata* are two distinct species, as they are so different in the postlarval, pelagic stages that they can be separated with the greatest ease even at the first glance, as will be shown below. Further, my investigations on the geographical distribution, so far as they have hitherto gone, seem to show that in this regard also, there is a characteristic difference between *M. byrkelange* and *M. elongata*.

The case is indeed perhaps the same for these two deep-water lings as it was for *Gadus luscus* and *G. minutus;* the better we learn to know the developmental history the more distinctly the differences appear, as these are most prominent in the earliest pelagic stages.

[1] A short description of the post-larval stages of this species was given in my paper: On the pelagic, post-larval Stages of the Lings (*Molva molva* [Linné] and *Molva byrkelange* [Walb.]). Meddel. Kom. Havund. Ser.: Fiskeri, Bind II, No. 3, 1906, p. 14. See further the postscript p. 13 at the end of this paper.

[2] E. W. L. Holt and L. W Byrne: First Report on the Fishes of the Irish Atlantic Slope (Fisheries, Ireland, Sci. Invest., 1905, II [1906] p. 24).

[3] Risso: Hist. nat. des princip. productions de l'Europe méridionale, T. III, p. 217, 1826.

The available material consists of ca. 10 pelagic stages varying in length from 2½ to 6 cm., all taken by the "Thor" over great depths S.W. of the British Isles. In this region a large number of hauls were made by the "Thor" during the search for Leptocephali, and the fact that we got no more than ca. 10 specimens shows perhaps that we have here the northern limit of the species.

1. Description of the developmental history

The specific name given by Risso, namely *elongata*, is also exceedingly suitable for the pelagic young of this species. No gadoid young is known to me which has so slender a form as *Molva elongata*, which might almost be said to be eel-shaped. The young of *M. elongata* stand in appearance much nearer to *M. byrkelange* than to *M. molva*, both in form and pigmentation. Before passing to the description of the available developmental stages I may just mention briefly the pigmentation characteristic of the *Molva*-genus (see further my paper mentioned on p. 3 footnote on the developmental history of *M. molva* and *M. byrkelange*).

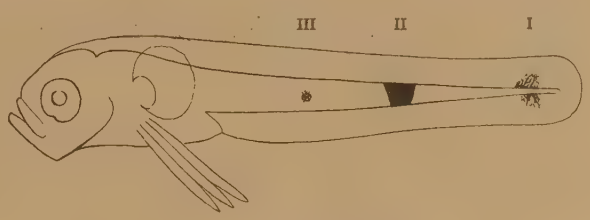

Fig. 1. *Molva byrkelange.*

In the earliest postlarval stages *M. byrkelange* (see Fig. 1 in Text) has three transverse pigment bars (I, II, III), of which I is situated near the end of the tail, III somewhat behind the anus and II almost midway between I and III. Later, in addition to these 3 primary bars several secondary ones appear, namely, one in front of III (III B), one behind III (III A), one in front of II (II B) and one behind II (II A) and finally one in front of I (I B).

We may now proceed to the description of *M. elongata:*

Length: 26 mm. The most striking characteristic of this and the other postlarval stages of *M. elongata* is, that the body is so extraordinarily thin and elongated that it might well be called eel-shaped. The preanal part of the body especially is unusually slender. Pl. I, Fig. 1

If we compare this specimen with one of *M. byrkelange* of the same length, the latter, though in itself also slender, would almost seem plump in form in contrast to *M. elongata*. The snout is pointed and the lower jaw projects beyond the upper. The eyes are relatively small, smaller than the distance from their anterior margin to the snout. Barbel can not be observed. The anus lies a good distance behind the interspace between D^1 and D^2 (in contrast to *M. byrkelange* where it is nearer the interspace between these fins).

The unpaired fins are almost fully developed. Thus the caudal fin is quite separated from D^2 and A and D^1 is also apparently distinct from D^2. The following number of rays were counted: D^1 ca. 9, D^2 ca. 75, A ca. 68, but the posterior rays in the fins are not yet quite so strong as they will be later. The caudal fin naturally has rays everywhere and the end of the notochord is already quite reduced and bent upwards and the posterior margin of the last hypural is vertical. The caudal is narrow, oval and rounded posteriorly. The ventrals as in the other species of this genus are very elongated and reach backwards at least to pigment bar No. II B, and perhaps even further in reality as they are worn at the tip. They contain 6 thin rays of different length enclosed in a membrane, which is however easily split so that they become partly free. Except on the proximal part this membrane is covered with pigment, which makes the fins appear dark, almost black (darker than represented in the figure). In contrast to the condition in *M. byrkelange* this pigment is not arranged in bars or rings, but is evenly distributed along the length of the fins.

The remaining pigment is characteristic, especially the postanal. The three original, primary pig-

ment bars (I, II, III, see above) can still be recognised, but the secondary bars are already much larger and stronger. Of these I B, II A and II B, as also III A and III B are very distinct. Whilst I B is chiefly limited to a well-marked ventral black streak at the base of the posterior part of A, II A and B and III A consist of broad, rounded pigment patches midway up the sides (not of narrow cross-bars as in *M. byrkelange*), and lastly, III B (somewhat behind the anus) has the form of a broad rounded spot placed mostly dorsally. There is no pigment on D^1 nor on the anterior parts of D^2 and A. The two latter fins lack on the whole the well-defined, separate pigment spots which characterize *M. byrkelange* (see Fig. 6—8, Pl. I), but by contrast they have another very characteristic arrangement. Somewhat in from the margins in the posterior part of D^2 and A there is a distinct longitudinal stripe of black pigment; this is most pronounced posteriorly but gradually fades anteriorly. In D^2 anteriorly it reaches to opposite bar No. II (or halfway between II A and II B); in A it reaches forwards to opposite II A and is thus shorter than that in D^2 (see fig. 1, Pl. I). These stripes or bands of pigment in D^2 and A posteriorly are very characteristic and obvious and constitute perhaps along with the thin shape of the body the characters by means of which *M. elongata* is most quickly and most readily distinguished from *M. byrkelange* in these stages.

The pigmentation of the caudal fin is also characteristic. The pigment here is placed a little distance away from the base of the fin-rays and extends in an arch from the anterior part of the fin above round the point of the tail then forwards to the anterior part of the fin below. This arched streak on the caudal fin is broadest posteriorly; it answers in form somewhat to the tail itself from which it is separated by a pigmentless belt. In *Molva byrkelange* any distinct, arched streak of pigment in the caudal fin is absent.

On dehydration and clearing in xylol, the number of vertebræ was determined in this specimen; the abdominal and caudal vertebræ were 34 and 50.

Pl. I, Fig. 2 **Length: 35 mm.** This specimen is in the main in the same condition as the first. The body is just as thin and slender (greatest height: ca. 3 mm.) and the development of the fins and pigment is essentially the same. The pigment is however stronger, especially bar No. II A, which is remarkable in being longer and darker than the others. The original bars I, II and III can still be traced by the presence of somewhat larger chromatophores in the place where they should be.

Pl. I, Fig. 3 **Length: 60 mm.** The description of the slender form of the body in the earlier stages still holds good. The greatest height of the body is thus contained quite 12 times in the total length. The eyes are rather small, less than length of snout (from eye to tip). A barbel was, though present, still difficult to see. The fins are fully developed. The ventrals are somewhat shorter but still reach a good distance behind the anus; they have very black pigment everywhere except on their proximal part. D^1 is low, relatively lower than in *M. byrkelange* and A goes a trifle further back than D^2. The caudal fin is narrow, oval and rounded posteriorly. The following number of rays were counted in the now fully-formed fins: D^1 11, D^2 79, A 76.

The pigment is in the main the same as before, but is stronger and more definite. Of the postanal bars II A especially is well-marked and remarkable further in being broader than the others. II B and III A are also prominent: they are almost square in form and like II A much broader than the corresponding bars in *M. byrkelange* (Pl. I, Fig. 7). III B (a little behind the anus) is also well-marked and almost square; in contrast to those described above it does not reach down quite to the ventral edge. Between the postanal transverse bars II A and II B as also between II B and III A and between III A and III B there are streaks of pigment dorsally, so that the upper portions of the bars are connected with one another. (See figure.)

In a *M. byrkelange* of similar length D^1 has 1, D^2 6 and A 4 well-defined, separate pigment patches. This is not the case here where D^1 in the first place quite lacks pigment. In D^2 and A posteriorly

there is always a pigment stripe instead of the separate patches in *M. byrkelange*. There are however indications present that these stripes are about to resolve themselves into separate patches, as is found later (see Pl. I, fig. 4). The pigment of the caudal fin has not essentially changed and consists still of an arched streak round the end of the tail.

This specimen of 60 mm. in length is the oldest pelagic stage I have seen.

In addition to the stages mentioned, of a length from $2^1/_2$ to 6 cm., I have taken a tiny postlarval stage of ca. 9 mm. in length S.W. of Ireland, which is however so damaged that a close description and figure would be of no value. It belongs perhaps to the present species and is remarkable in that the ventral fins are so extremely elongated that they reach a good distance beyond the end of the tail. The body is still surrounded by the embryonic fin. The pigmentation could not be determined on this damaged specimen.

The next stage in the developmental series was not like the above taken by the "Thor" in the Atlantic but comes from the Naples Zoological Station. Although it is a bottom-stage which has already passed beyond the postlarval development, I shall describe it briefly here, as it is of interest to follow the further development in this species.

Length: ca. 110 mm. The body is slender as in the earlier stages (the greatest height is contained ca. 12 times in the total length). The eyes are small, much smaller than the length of the snout and a slender barbule is present. The ventrals are now short and are far from reaching to the anus. Quite the same pigment bars are present as in the previous stage and they have the same broad form as before, so that (at least II B as well as III A and III B) they are almost square-shaped (in contrast to *M. byrkelange*, a somewhat smaller specimen of which is figured in fig. 8). The interspace between the pigment bars is filled dorsally, but not ventrally, by a broad pigment streak and ventrally by almost pigmentless bars which are also approximately square in shape; thus the sides of the body have a characteristically chequered marking. The pigment of the caudal consists now of a broader arch. D^1 has its group of pigment and the earlier pigment streak on D^2 has now resolved itself into 6 patches, the position of which can be more easily and better understood from the figure than from a description. In A the streak is resolved into only 2 patches, which are placed posteriorly in the fin opposite I B and II A. Some pigment-spots between these two patches show that they have earlier been connected. Pl. I, Fig. 4

To describe still older stages is superfluous, as the description of the pelagic postlarval stages from the Atlantic S.W. of the British Isles has now been supplemented by that of the young specimen from the Mediterranean.

2. Verification of the determinations

In my earlier mentioned paper on the developmental history of *Molva molva* and *M. byrkelange* (see footnote p. 3), the number of fin-rays etc. is given for those species.

For *Molva elongata* Risso (l. c. p. 218) gives the following: D^1 12, D^2 82, A 76, C 38, P 18 and V 6 rays.

Moreau (Poissons de la France, vol. III, p. 260—261, 1881) gives for *Molva elongata*, which he mentions as only occurring in the Mediterranean, the following numbers: D^1 10—12, D^2 77—82, A 70—77, C 38—45, P 18 and V 6. Lilljeborg (l. c.) gives for *Molva elongata* 10—12 usually 10 rays in D^1.

In 3 adolescent specimens of *Molva elongata* brought from Naples by Dr. C. G. Joh. Petersen, I found the following numbers in D^1: 10, 10, 11. In one of these the number of vertebræ was $36 + 46 = 82$, in another $34 + 48 = 82$ (counted by cand. mag. A. Strubberg).

We have then the following summary:

	Molva molva	*M. byrkelange*	*M. elongata*
Rays in dorsals.....	13—16 + 62—70	13—15 + 74—85	10—12 + 77—82
— - anal	57—66	74—81	70—77
Abdominal vertebræ .	25—27	76—79	34—36
Caudal vertebræ	37—39	45—47	46—48
Total vertebræ.....	63—65	76—79	82

After determining that the very slender, postlarval ling specimens described were different from *M. byrkelange* it was in the nature of the case evident that they must belong to *M. elongata*, especially as only three species of this genus are known to exist, viz. *M. molva* (which was excluded by many characters), *M. byrkelange* and *M. elongata*. Further they agreed with *M. elongata* in the slender form of body, in the relatively small eyes, the number of fin-rays (especially in D^1) and in the number of vertebræ, which after dehydration and clearing in xylol I found in 3 postlarval specimens to be 34/50, 34/49, 36/47; this was greater therefore than in *M. byrkelange*.

It appeared further, however, that there was very good agreement between the pelagic specimens from the Atlantic S.W. of the British Isles and some young specimens of *M. elongata* from the Mediterranean (Naples) which I was able to examine. One of these, ca. 11 cm. in length, is represented in Pl. I, fig. 4, along with a *M. byrkelange* of ca. 8 cm. (fig. 8), and we thus see that it has the same broad postanal, pigment bars as the postlarval stages from the Atlantic (fig. 1, 2, 3). There is also very good agreement in the narrow shape of the caudal fin, in the arched form of the pigment on this, in the slenderness of the body and in the relatively small size of the eyes.

3. Distinction between the postlarval stages of *M. elongata* and related species

The only species with which *M. elongata* can possibly be confused is *M. byrkelange*. As I am not in possession of the earliest postlarval stages of the former, I am unable to give the diagnostic characters for these stages[1]. The pelagic postlarval stages from ca. $2^1/_2$ cm. onwards are distinguished from those of *M. byrkelange* first and foremost by the much thinner and slender form; further, by the greater number of vertebræ, by the position of the anus, by the smaller number of rays in D^1 and by the smaller eyes. The pigmentation also shows obvious differences. Thus the secondary, postanal pigment bars are much broader in *M. elongata* than in *M. byrkelange* (cf. figs. 1—4 and 5—8, Pl. I). In *M. elongata* there is in D^2 and A posteriorly a continuous streak of pigment in from the margin which is lacking in *M. byrkelange*, and the pigment on the caudal fin consists of an arched streak at the base of the fin, which in its course runs parallel to the contour of the tail itself, whilst in *M. byrkelange* the pigment on the caudal fin has more the form of a transverse bar sharply defined posteriorly, like the other postanal transverse bars.

Further the pigment on the ventrals is more uniformly distributed over the whole length with exception of the proximal part in *M. elongata*, whereas in *M. byrkelange* it is arranged in bars. Lastly, it may be mentioned that the barbel is already very distinct in *M. byrkelange* at a length of ca. 3 cm., whilst in *M. elongata* even at a length of 6 cm. it was still difficult to distinguish.

As already mentioned, the distribution of the two species is also very different. Whilst *M. byrkelange* is common on the west and south coasts of Iceland and further south to Scotland and N.W. Ireland, *M. elongata* which is common indeed in the Mediterranean, has not hitherto been found further north in the Atlantic than south of the great bank which pushes out into the Atlantic to the west of Ireland — south of which the temperatures even at considerable depths are relatively very high.

[1] If the earlier mentioned (p. 11) damaged tiny specimen of ca. 9 mm. belonged to *M. elongata*, the early postlarval stages might be distinguished from *M. byrkelange* in that their ventral fins are still more prolonged than in the latter, reaching posteriorly beyond the end of the tail.

POSTSCRIPT

NOTE TO THE DESCRIPTION OF *MOLVA ELONGATA* (RISSO)

After the above was in proof I came across a recent paper by Mc. Intosh in Notes from the Gatty Marine Laboratory, St. Andrews, No. XXVII, entitled: "On a very young Stage of *Phycis blennoides*, Bl."[1] As soon as I saw Mc. Intosh's figures of this supposed *Phycis* I felt sure that his determination was incorrect and that the little fish was really a *Molva elongata*. This opinion was strengthened on reading through his description of the supposed *Phycis* postlarva, which was taken pelagically at Messina in April 1905.

On p. 67 (l. c.) it is stated:

> "The little fish (pl. II, figs. 1 & 2) has a total length of 35 mm. and the vertical diameter of the body at the vent is 3 mm. whilst the long pelvic fins reached a length of 13 mm. No silvery sheen is present in the preparation. The pigment has been removed to a considerable extent by the spirit, but five distinct and broad bars[2] occur along the sides and traces of a sixth appear at the narrow region in front of the caudal. Moreover several of these are faintly continued at the ventral surface. The first lies behind the pectoral.[3] The dorsum of the head also shows blackish pigment, and a band of the same pigment extends within the margin of the second dorsal about a third of its length posteriorly, a similar band characterising the border of the anal fin. In both fins the posterior end of the band is broadest etc."

This quotation shows at once that Mc. Intosh's *Phycis* postlarva was really a *Molva elongata*, as his description and figures agree in all details with my specimens of *Molva elongata*, even to the presence of the characteristic arch of pigment on the caudal fin which is well shown in his figure. On reading his description further also, we obtain further confirmation of this; it seems on the whole indeed that the author found it somewhat difficult to make the characters of the postlarva determined as *Phycis* agree with those of the adult fish. Thus on p. 67 he states: "The second dorsal has about 78 rays — considerably more than the type; and the anal has 74, also considerably more than in the adult."[4] And to explain this difference the author has recourse to the peculiar hypothesis, that during the later development there may occur a fusion of some of these rays at the anterior or posterior ends of the fins, a condition I have never seen in any fish young. In other respects also Mc. Intosh's postlarva according to his description differs from *Phycis* and agrees with *Molva elongata*, e. g. in the form of the caudal fin, in the projection of the mandible beyond the upper jaw, etc.; on clearing and counting the vertebræ it will undoubtedly prove that the specimen in question has more than 80 vertebræ instead of ca. 50 (as in *Phycis blennoides*).[5]

[1] Annals and Magazine of Natural History; vol. XVII, 7th series, London 1906, p. 66—72, Pl. II, figs. 1—2.

[2] The emphasis is mine.

[3] This first bar is fainter in my specimens but is still quite distinct on viewing the specimens from the dorsal aspect.

[4] *Molva elongata* has 77—82 rays in D^2 and 70—77 in A (see p. 12), whereas *Phycis blennoides* according to Lilljeborg (l. c., p. 156) has 54—63 in D^2 and 51—58 in A. The number of rays found by Mc. Intosh thus agrees excellently well with *Molva elongata* but not with *Phycis blennoides*.

[5] Mc. Intosh's statement that his postlarva from the Mediterranean has only 3 ventral rays (like *Phycis*), perhaps comes from the fact that the lower (outer) rays in the ventral in the postlarval *Molva* are very short and thus difficult to see.

EXPLANATION OF PLATE

Molva elongata (Risso).

Fig. 1. Length: 26 mm. "Thor", Stat. 81, 14th June 1905. 51° 32′ N, 12° 03′ W (S.W. of Ireland). Depth: 1090—1330 meters. Young-fish trawl, 200 meters wire out.

Fig. 2. Length: 35 mm. "Thor", Stat. 64, 5th June 1906, 49° 17 N, 14° 03′ W (S.W. of Ireland). Depth: > 3000 meters. Young-fish trawl, 200 meters wire out.

Fig. 3. Length: 60 mm. "Thor", Stat. 80, 16th June 1906. 51° 34′ N, 11° 50′ W (S.W. of Ireland). Depth: 1200 meters. Young-fish trawl, 100 meters wire out.

Fig. 4. Length: 110 mm. Zoological Station, Naples.

Molva byrkelange (Walb.) (= *M. abyssorum* Nilss.).

Fig. 5. Length: 23½ mm. "Thor", Stat. 64, 30th May 1905, 59° 17′ N, 7° 29′ W), Depth: 895 meters. Young-fish trawl, 65 meters wire out.

Fig. 6. Length: 36½ mm. "Thor", Stat. 71, 6th June 1905, 57° 47′ N, 11° 33′ W), Depth: 1985 meters. Young-fish trawl, 300 meters wire out.

Fig. 7. Length: 51 mm. "Thor", Stat. 190, 14th July 1904, 63° 29′ N, 21° 25′ W (South Iceland), Depth: 94—120 meters. Young-fish trawl, 110 meters wire out.

Fig. 8. Length: 78½ mm. "Thor", Stat. 185, 12th July 1904, 63° 16′ N, 19° 17′ W, Depth: 620 meters. Young-fish trawl, 75 meters wire out.

Raniceps raninus Linné.

Fig. 9. Length: 5 mm. "Thor", Stat. 170, 29th August 1906, 51° 57′ N, 10° 27′ W (S.W. Ireland), Depth: 77—80 meters. Young-fish trawl, 150 meters wire out.

Fig. 10. Length: 7½ mm. "Thor", Stat. 170, 29th August 1906 (same station as Fig. 9). Young-fish trawl, 65 meters wire out.

Fig. 11. Length: 9½ mm. "Thor", Stat. 170, 29th August 1906, same haul as Fig. 9.

Fig. 12. Length: 12¼ mm. "Thor", Stat. 165, 24th August 1906, 49° 49′ N, 6° 20′ W (English Channel), Depth: 72 meters. Young-fish trawl, 140 meters wire out.

Fig. 13. Length: 17¼ mm. "Thor", Stat. 170, 3rd September 1905, 58° 08′ N, 2° 22′ W (Moray Firth), Depth: 70 meters, Young-fish trawl, 65 meters wire out.

Fig. 13 a. The same specimen as Fig. 13, seen from the ventral aspect.

Fig. 13 b. The same specimen as Fig. 13, seen from the dorsal aspect.

550. 3/IX 1907.

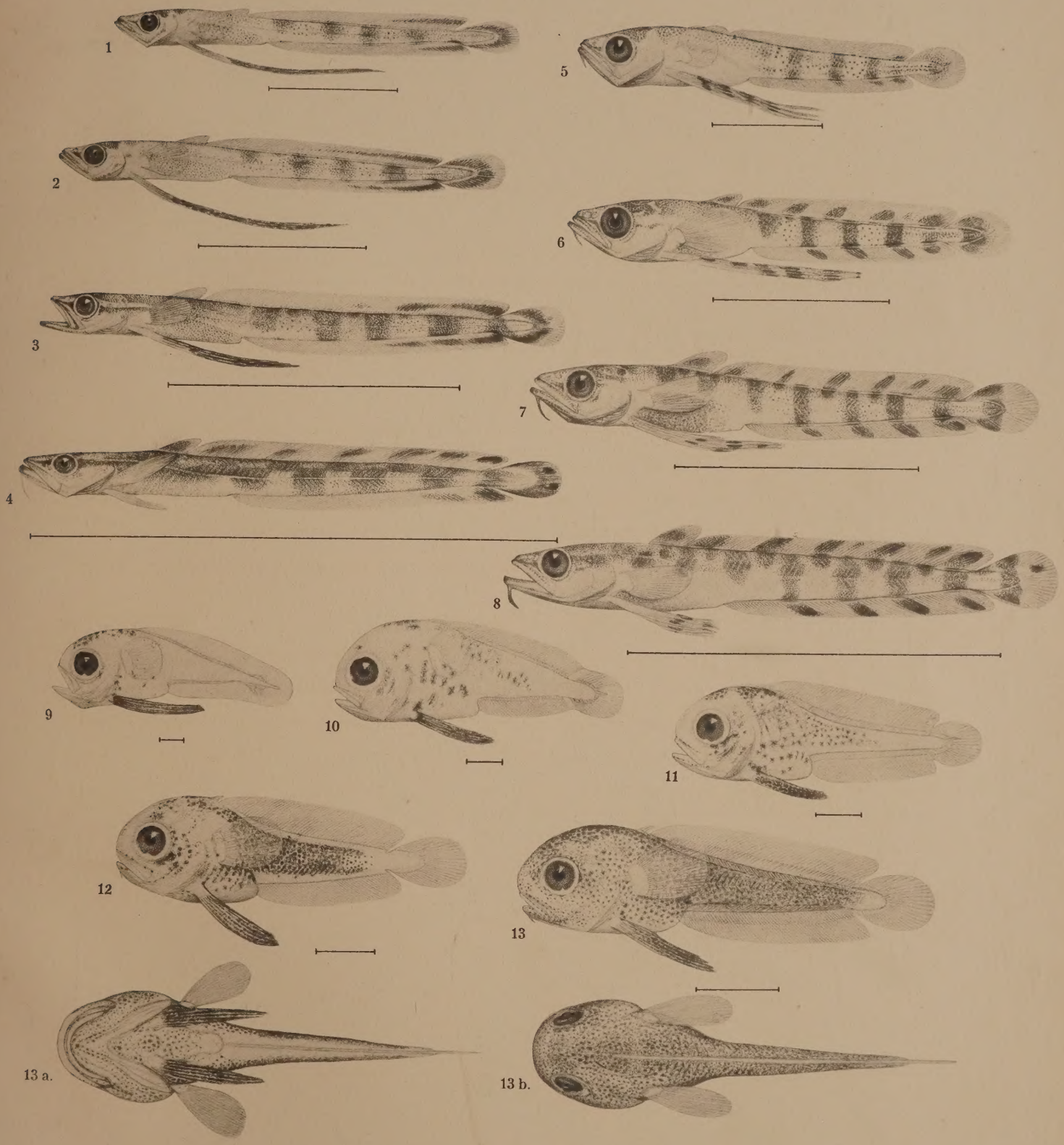

Fig. 1—4 *Molva elongata* (Risso). Fig. 5—8 *Molva byrkelange* (Walb). Fig. 9—13 *Raniceps raninus* (Linné).

H. V. Westergaard del.

Pacht & Crone phototyp.